Below are two particles with +0.1µC and -0.1µC charges separated by 0.5 mm (1µC = 10⁻⁶ C). You will calculate the electric field on the axis in two ways. First superimposing the electric fields from point charges, and second by modeling the plus and minus charges as an electric dipole.

a) Using superposition, calculate the x and y-components of the electric field at the point indicated below on the axis of the charges. Do not use any approximations.

\[ \mathbf{E}_x = \text{Value} \quad \text{Units} \]

\[ \mathbf{E}_y = \text{Value} \quad \text{Units} \]

c) Calculate the electric field at the point indicated above using the dipole approximation for electric fields on the axis, \( |\mathbf{E}| = k2p/r^3 \).

\[ \mathbf{E}_x = \text{Value} \quad \text{Units} \]

\[ \mathbf{E}_y = \text{Value} \quad \text{Units} \]
c) Explain similarities / differences between these two calculations.


d) Sketch graphs of \( E_x \) and \( E_y \) vs position along the vertical line indicated below. For example, the point \( y=0 \) mm is the point at which you calculated the field components in part \( a \).